Molecular and isotope characterization of soil lipids along a savannah (C4)/eucalyptus (C3) chronosequence (Pointe-Noire, Congo)

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The surfaces dedicated to forestry plantations are rapidly increasing throughout the world, especially in the tropics [1]. The impacts of such a rapid afforestation on global carbon cycle and on soil that constitutes one of its key compartment, is therefore a critical issue [2]. Stable carbon isotope characterization of C_4/C_3 chronosequences has proven useful in assessing the dynamics of organic carbon in soils [3]. Lipids are important contributors to organic matter in soils since they can influence aggregate stability, water retention and fertility. Nevertheless, little is known on the effects of afforestation on lipid composition and dynamics in tropical soils. The eucalyptus plantation located in the area of Pointe-Noire (Republic of Congo) is a prime field to study the impact of afforestation on organic carbon dynamics. Indeed, a eucalyptus forest (C_3) has been progressively planted on savannah (C_4) during the last 30 years [4]. Lipids were solvent-extracted from the top soil (0-20 cm) of stands planted for 7, 17, 30 years, and of a reference plot of the initial savannah. They were also extracted from the main savannah species and from eucalyptus.

Lipids accounted for 0.3 to 0.9 wt % of the dried soils. Gas chromatography-mass spectrometry analyses of soil lipids revealed a complex mixture comprising more than 100 identified constituents, belonging to diverse chemical families (e.g. fatty lipids, triterpenes, sterols, glycerols). Most of these molecules correspond to plant components, emphasizing the importance of this source of organic matter to soil lipids. Afforestation did not appear to affect significantly bulk lipid yields. Most of the identified components are present all along the chronosequence. Nevertheless, quantification of the main compounds revealed, for some of them, significant trends related to the vegetation changes: (i) decrease of savannah grasses markers (very long chain fatty lipids, pentacyclic triterpene methyl ethers), (ii) increase of eucalyptus contribution (long chain fatty lipids) and (iii) increase of microbial marker (cholesterol). Compound-specific $\delta^{13}C$ analyses were performed (1) on odd carbon chain length *n*-alkanes from 25 to 31 carbon atoms that are specific to higher plants and common to both vegetations and (2) on savannah grass markers. After 30 yrs of eucalyptus crop, the $\delta^{13}C$ of soil C_{25} and C_{27} *n*-alkanes displayed typical trend of a C_4/C_3 vegetation shift with a depletion of 4.4 ‰ and 6.4 ‰ (Fig. 1). Surprisingly, the C_{29} *n*-alkane $\delta^{13}C$ is of -30.5 ‰ for all stands, pointing to additional sources for this compound. The isotopic signature of the C_{31} *n*-alkane showed no incorporation from the eucalyptus plant, as for pentacyclic triterpene methyl ethers. Compound-specific ^{14}C analyses are under progress to precise the origin and the residence time of the different markers in soil.

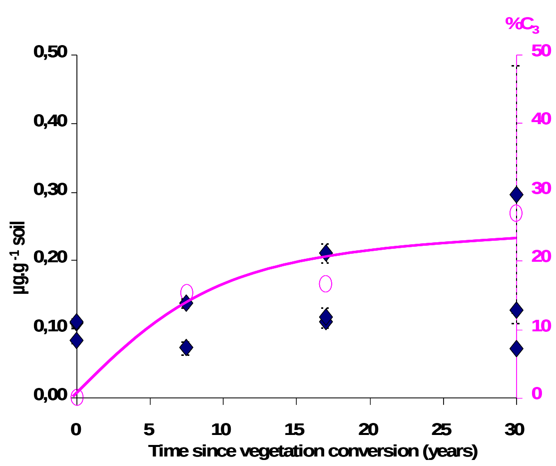

Fig. 1. C_{25}-alkane dynamics

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